

****FULL TITLE****

*ASP Conference Series, Vol. **VOLUME**, **YEAR OF PUBLICATION***

****NAMES OF EDITORS****

The PSU/TCfA Search for Planets Around Evolved Stars: $V \sin i$ Measurements for Slow Rotating F-K Giants.

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Abstract. We present results of our projected rotational velocities ($V \sin i$) measurements of F, G and K giants obtained from the cross-correlation function (CCF) constructed from high signal to noise spectra. We also present the calibration of the HET/HRS cross-correlation function to determine accurate projected rotational velocities $V \sin i$ for slowly-rotating F-K giants.

Introduction and observations

By fitting a Gaussian to the CCF profile we obtain three free parameters: position of the minimum (which is directly related to the radial velocity), dispersion σ_{obs} (related to the surface velocity field) and the cross correlation area (related to the stellar metallicity). If we measure σ_{obs} for stars for which accurate $V \sin i$ were determined by Fourier analysis or from rotational periods, we may build a calibration of the CCF technique to determine accurate $V \sin i$.

The observational material and reduction are described in Niedzielski & Wolszczan (this volume).

The σ_0 - $V \sin i$ calibration for HET/HRS and preliminary results

We obtained the CCF by cross correlating the high S/N blue spectra with a numerical mask defined as a sum of delta-functions centered on the rest wavelengths of selected lines (since the mask is a mathematical function it does not add noise to the data). After computing the CCFs for every order, they are adjusted to a common reference frame and co-added to get the final normalized CCF for which the *FWHM* is measured. The dispersion (σ_{obs}) is related to *FWHM* as: $FWHM = 2\sqrt{2\ln(2)}\sigma_{obs}$.

Benz & Mayor (1984) have shown that the width of the CCF (σ_{obs}) is related to the $V \sin i$ by a function of a form of: $V \sin i = A\sqrt{\sigma_{obs}^2 - \sigma_0^2}$, where A is a constant coupling the differential broadening of the CCFs to the $V \sin i$ of a star, and σ_0 is the width of the CCF of an non-rotating star of the same spectral type and luminosity and is related to the measured width of the CCF (σ_{obs}) by the following formula: $\sigma_{obs}^2 = \sigma_0^2 + \sigma_{rot}^2$. The measured width of the CCF

of a star (σ_{obs}) results from several broadening mechanisms: gravity, effective temperature, magnetic field, metallicity, and of course the rotation. σ_{rot}^2 is the rotational broadening and σ_0^2 is responsible for all other broadening mechanisms (including the instrumental profile) except rotation. σ_0 is a critical parameter. It is a function of the color of a star and we may obtain its dependence on $(B - V)$ by using slowly-rotating calibrator stars. To determine the σ_0 vs. $(B - V)$ relation we used 16 slow rotators with accurate projected rotational velocities measured in various papers, preferably from by Gray (1989), Fekel (1997) and de Medeiros & Mayor (1999). For every of these stars we determined σ_0 using formula from Benz & Mayor (1984) and assuming the constant $A = 1.9$ following the Queloz et al. (1998) and Melo et al. (2001). We carried out a least-squared fit to the data by the analytical function $\sigma_0 = a_2(B - V)^2 + a_1(B - V) + a_0$ which yields the following calibration: $\sigma_0 = 15.592(B - V)^2 - 26.753(B - V) + 14.559$.

Table 1. HET/HRS $V \sin i$ for several stars from our survey and their comparison with previous work: (a) Fischer & Valenti (2005), (b) Da Silva et al. (2006).

Name	Spectral type	$B - V$	σ_{obs}	$V \sin i$ HET/HRS	$V \sin i$ other
HD 17092	K0	1.000	3.437	0.98	-
HD 38529	G4V	0.773	3.551	2.94	3.90 ^a
HD 118203	K0	0.810	3.896	4.44	4.70 ^b
HD 10697	G5IV	0.860	3.288	2.17	2.48 ^a
HD 88133	G5IV	0.860	3.167	1.38	2.17 ^a
HD 75732	G8V	0.869	3.136	1.07	2.46 ^a
HD 95296	K0	1.000	3.484	1.46	-
HD 77819	G5	0.860	3.845	4.37	-
BD+57 114	G4V	0.940	3.720	3.64	-

In table 1 we present projected rotational velocities for several stars from our survey (the typical error of our measurements is about 1.5 km/s). It is clear, that our measurements are in good agreement with previous determinations.

Acknowledgments. We thank the HET resident astronomers and telescope operators for cooperation. We acknowledge the financial support from the MNiSW through grant 1P03D 007 30. GN is a recipient of a graduate stipend of the Chairman of the Polish Academy of Sciences.

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